Pneumatic Conveying System

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Abstract— In the era of competition in manufacturing sector, fast product development with better accuracy and tolerance is the utmost requirement. Most of the small scale industries uses chain pulley which is very time consuming, very laborious and a tedious job. It requires many hours as well as many labours to transfer the job/work piece from one place to another. As well as the workers have to do the over time in the company. Pneumatic Conveying System is the replacement of the conventional chain pulley system. This system reduces much amount of load on the workers as it is operated just by pressing the buttons it transfer load from one place to another . Result in increase in the efficiency of the workers and reduces the delay time which results in increase in productivity of the industry.

Key words: Pneumatic Conveying System, Chain Pulley, Transport, Conveyor

I. INTRODUCTION

In industry ,as per the past scenario as well as in the recent time, workers used to transfer load with the help of chain pulley system .Chain pulley system consists of pulley, gears and chain. It works on differential pulley mechanisms. Sometimes chain falls or chain hoist are utilized in manual lifting of very heavy components or objects like automobile engine, raw material, unfinished goods or finished products. The mechanism work on pulling upon the slag section (loose) for a continuous chain that is wrapped around pulley .The comparative ratio of two connecting pulley decides the maximum load that can be lifted manually. Instead of chains, ropes, belts, cables can be also be used. It works on torque transferring which results in lifting of load consisting of lifting hook. Hook which is a device used for lifting or grabbing different loads by using crane or hoist, But recently as observed by us in recent days that the worker had to make 10 revolutions for lifting a work piece of more than 100 kg for 1 inch. As a result of this we observed that there was lot of time consumed in just transferring the load from one position to another. if somehow, we could be able to reduce the transferring time there would be reduction in ideal time for machining purpose .As a result more products can be produced and company or industry can manufacture products at relatively cheaper rates increasing its market value within the consumer and supplier and overall increase in output efficiency of the organization. We approach to a solution of applying pneumatics for transferring the loads within the industry as a result by which we could be overcoming the drawbacks which were faced due to chain pulley system that is mainly delay in time. Therefore we can conclude that in industries high speed systems with high accuracy are growing up rapidly so pneumatic system has been taken as a relevant solution of the faced problem.

II. PROBLEM DEFINITION

The problems faced by the users through current system in industries are:

- The current method of chain pulley is very time consuming.
- The current method is very laborious.
- The cleaning and maintenance is a difficult task in chain pulley.
- Due to miscommunication between worker job, raw material or finished goods may get damage.

III. IDEA DEVELOPMENT

After Observing problem faced in the current method used in the industries and using the recent knowledge gained in the pneumatic workshop organized at GTU headquarters ”VISHWAKARMA” by BOSCH company at dates 5/6/7 of August 2017.We approach to a solution of applying pneumatics for transferring the loads within the industry as a result by which we could be overcoming the drawbacks which were faced due to chain pulley system that is mainly delay in time

IV. OBJECTIVES

The main objectives of our project are

- To help the workers, laborers and other users to easily transfer the loads.
- To reduce their efforts and struggle for transferring the loads.
- To focus on how we can reduce the cost by the material selection and make the design more compact.

V. CONCEPT DESIGN

A. Brief about Components

1) Pneumatic Actuator

A pneumatic control valve actuator converts energy (typically in the form of compressed air) into mechanical motion. The motion can be rotary or linear, depending on the type of actuator.

Types of pneumatic actuators cylinders:

a) Single Acting Cylinder

A cylinder in which air pressure is applied to the movable element (piston) in only one direction.

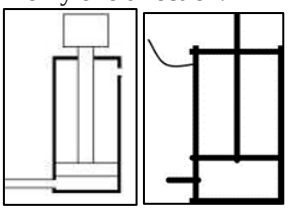

Fig. 1:

b) Spring Return Cylinder

A cylinder in which a spring returns the piston assembly.

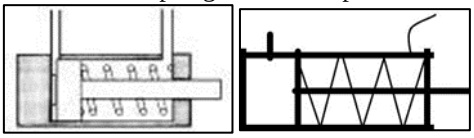

Fig. 2:

c) Ram Cylinder

A cylinder in which the movable element is the piston rod.

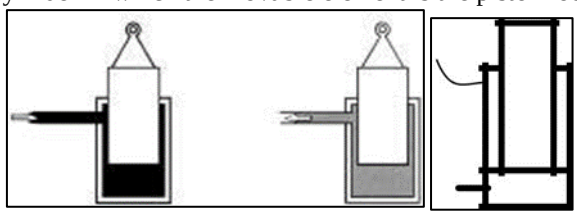

Fig. 3:

d) Double Acting Cylinder

A cylinder in which air pressure may be alternately applied to the piston to drive it in either direction.

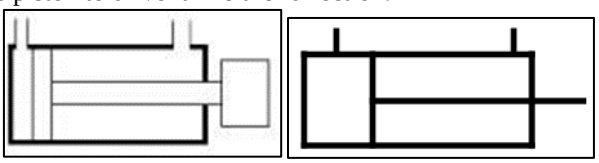

Fig. 4:

e) Double acting – double rod cylinder

Double acting cylinder with a piston rod extending form each end. The piston rods are connected to the same piston. Double rod cylinders provide equal force and speed in both directions.

Fig. 5:

2) Pressure Regulator

It is a device which regulates the air pressure as per requirement.

Fig. 6:

3) Filter Regulator Lubricator (FRL)

Air leaving a compressor is hot, dirty, and wet which can damage and shorten the life of downstream equipment, such as valves and cylinders. Before air can be used it needs to be filtered, regulated and lubricated.

An airline filter cleans compressed air. It strains the air and traps solid particles (dust, dirt, rust) and separates liquids (water, oil) entrained in the compressed air. Filters are installed in the air line upstream of regulators, lubricators, directional control valves, and air driven devices such as cylinders and air motors.

Fig. 7:

4) Compressed Air Storage Tank

It is a reservoir used to store the compressed air which is compressed by the compressor and it is the primary source of pressure for the pneumatic wrench to operate.

Fig. 8:

5) Directional Control Valves

To change the direction of airflow to and from the cylinder, we use a directional control valve. The moving part in a directional control valve will connect and disconnect internal flow passages within the valve body. This action results in a control of airflow direction.

The typical directional control valve consists of a valve body with four internal flow passages within the valve body and a sliding spool.

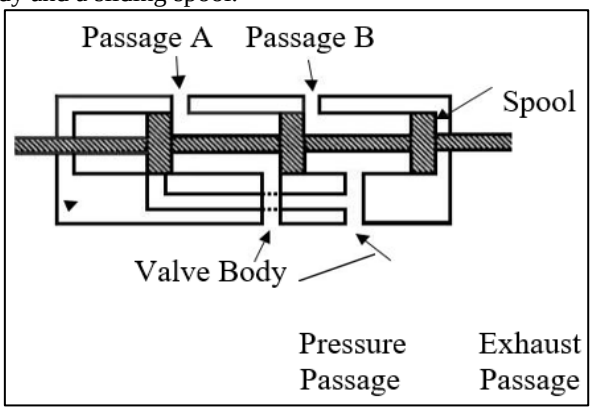

Fig. 9:

Shifting the spool alternately connects a cylinder port to supply pressure or the exhaust port. With the spool in the position where the supply pressure is connected to port A and port B is connected to the exhaust port, the cylinder will extend. Then, with the spool in the other extreme position, supply pressure is connected to port B and port A is connected to the exhaust port, now the cylinder retracts. With a directional control valve in a circuit, the cylinder's piston rod can be extended or retracted and work performed.

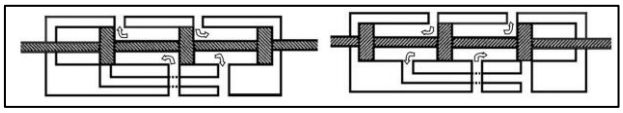

Fig. 10:

B. Functional Types of Directional Control Valves

One method of classifying a directional control valve is by the flow paths that are set up in its various operating conditions. Important factors to be considered are the number of individual ports, the number of flow paths the valve is designed for and internal connection of ports with the movable part.

1) Two-Way Directional Valve

A two-way directional valve consists of two ports connected to each other with passages, which are connected and disconnected. In one extreme spool position, port A is open to port B; the flow path through the valve is open. In the other extreme, the large diameter of the spool closes the path between A and B; the flow path is blocked. A two-way directional valve gives an on-off function.

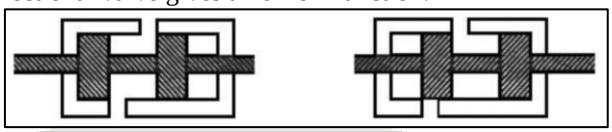

Fig. 11: Flow Path Open Flow Path Closed

Fig. 12:

2) Three-Way Directional Valve

A three-way directional valve consists of three ports connected through passages within a valve body that are shown here as port A, port P and port Ex. If port A is connected to an actuator, port P to a source of pressure and port Ex is open to exhaust, the valve will control the flow of air to (and exhaust from) Port A.

The function of this valve is to pressurize and exhaust one actuator port. When the spool of a three-way valve is in one extreme position, the pressure passage is connected with the actuator passage. When in the other extreme position, the spool connects the actuator passage with the exhaust passage.

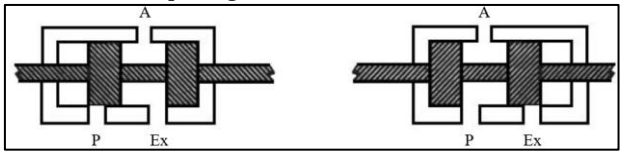

Fig. 13:

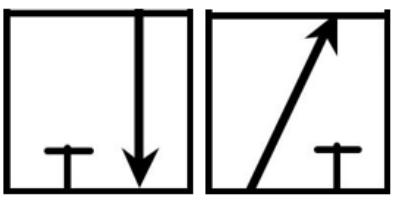

Fig. 14:

3) Four-Way Directional Valve

Perhaps the most common directional valve in simple pneumatic systems consists of pressure port, two actuator ports and one or more exhaust ports. These valves are known as four-way valves since they have four distinct flow paths or "ways" within the valve body.

A common application of four-ported four-way directional valve is to cause reversible motion of a cylinder or motor. To perform this function, spool connects the pressure port with one actuator port. At the same time, the spool connects the other actuator port with the exhaust port. This is a four-ported four-way valve.

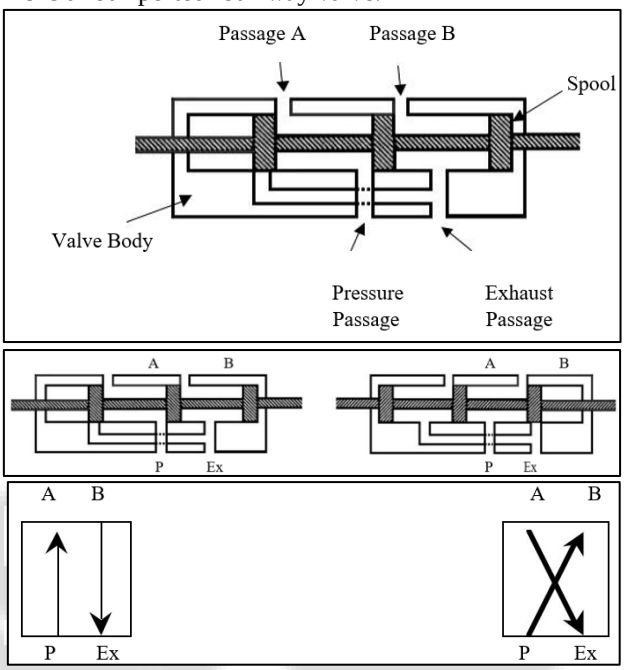

Fig. 15:

4) Five-Port / Four-Way Directional Valve

Four-way valves are also available with five external ports, one pressure port, two actuator ports, and two exhaust ports. Such valves provide the same basic control of flow paths as the four-ported version, but have individual exhaust ports. In the fluid power field this is referred to as a "five-ported, four-way valve." This type of valve brings all flow paths to individual external ports. The pressure port is connected to system pressure after a regulator. Actuator ports are connected to inlet and outlet ports of a cylinder or motor. Each exhaust port serves an actuator port.

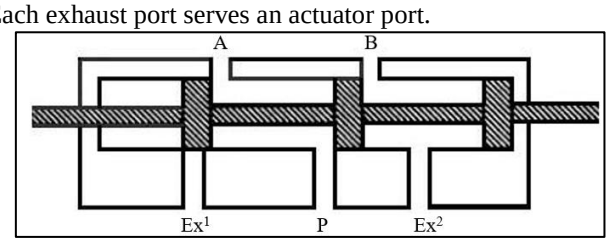

Fig. 16:

5) 5-Ported, 4-Way Valve

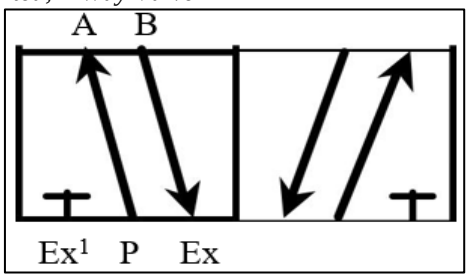

Fig. 17:

C. Schematic Symbols for Directional Valves

A directional valve is a valve that directs the flow of air in one with or another. It doesn't throttle or meter the airflow, and it doesn't change the pressure of the air. It just changes the direction of the airflow in some way. The ANSI symbol for directional valves are the most complicated of all the fluid power symbols, but some of the most important, so let us start with directional valves, see how the symbol system works. A typical directional valve symbol is made up of three parts:

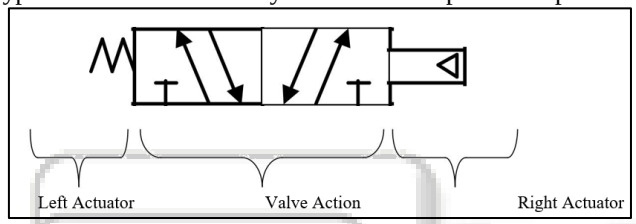

Fig. 18:

The actuators are the devices or methods that cause the valve to shift from one position to another. The valve action refers to the combinations of positions and flow paths which the valve offers.

1) Pneumatic Pipes

Pneumatic tubes (or capsule pipelines; also known as pneumatic tube transport or PTT) are systems that propel cylindrical containers through networks of tubes by compressed air or by partial vacuum.

Fig. 19:

2) Grippers

A pneumatic gripper is a specific type of pneumatic actuator that typically involves either parallel or angular motion of surfaces, A.K.A. "tooling jaws or fingers" that will grip an object.

There is well known that robotic devices and implements have been used in a variety of fields where direct human involvement is either too hazardous, too inefficient, or too monotonous and tiring. Examples of such fields include manufacturing where robots are used to carry out, pickup and assembly parts, welding, nailing and riveting, etc., handling of hazardous material such as radioactive products where direct human handling could pose a health risk, and remote handling or manipulation of articles, control panels, or other structures where onsite location of humans is desirable or possible.

End effectors, sometimes referred to as mechanical hands, robotic hands or grippers, are employed for a wide range of applications where mechanical manipulation is required. In particular, virtually any industrial or other application of robotics requires an end effectors of some type to provide a manipulation capability.

Accordingly non-specific end effectors are typically complex, have a large degree of freedom and employ Complex actuation mechanisms. They may attempt to emulate the human hand, and are often referred to as robotic hands.

Robotic grasping implements currently available range from the simple two jaw gripping device formed similar to the jaws of a pair of pliers, to the more complicated artificial hands having three or

VI. ADVANTAGES OF THIS GRIPPER

- A very strong grasping force using small size pneumatic cylinder;
- Both arms of the gripper are actuated simultaneous.
- The gripper is mounted on a mechanical arm which belongs to an automatic molding machine. In order to find out the working space and to obtain an optimized solution, the authors developed a 3D representation of the gripper and then of the gripper mounted on the mechanical arm.
- Another important feature of this gripper is a very strong grasping force using small size pneumatic cylinder. Also, the gripper has reduced dimensions (considering other solutions of the same kind).

A. Types of Grippers

- Rollers which are used mainly for pick and place operations and are based on the principle of rolling the material.
- Two Fingered gripper mechanisms were developed, utilizing mainly for operations of stacking and restacking.
- Surface Grippers. A group of surface grippers employ cushions implanted with pins or hollow adjustable needles to seize the fabric for pick and place operations.
- Adaptable grippers. Adaptable Grippers are complex gripping systems which can grasp any irregular shaped flat material.

VII. MATERIAL SELECTION

A. Actuators

PART	MATERIAL
BODY	Aluminum
Cover	Aluminum
Piston with Rack	Aluminum
Pinion	Steel/EN
Pinion bearing	Polycetal
Centre bore sleeve	polycetal
Cam insert	steel
External circlip	Spring steel

Cover seal	NBR
Piston seal	Polyethylene
Spring	Spring steel gr3
Slide ring	Polyacetal
Pinion seal	Polyethylene

Table 1:

Aluminum for actuators is distinguished from other materials due to its important features of lightness, resistance (to water, corrosion and UV rays), recyclability, safety, functionality, scalability and optimal performance in the long term.

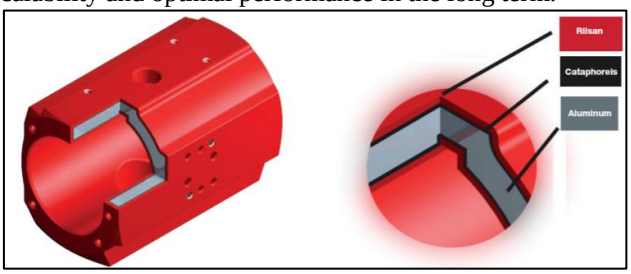

Fig. 20:

1) CATAPHORESIS

Electrochemical process that provides high corrosion resistance by means of 20 microns of uniform epoxy resin surface

2) RILSAN

Polyamide 11 coating (250microns). Offers high resistance to corrosion, wearing and impacts.

316 Stainless Steel Mechanical Properties

AISI Type 316/316L Stainless Steel, annealed, cold drawn, round

MECHANICAL PROPERTIES	METRIC	ENGLISH	COMMENTS
Hardness, Brinell	146	146	
Hardness, Knoop	166	166	Converted from Brinell hardness
Hardness, Rockwell B	79	79	Converted from Brinell hardness
Hardness, Vickers	152	152	Converted from Brinell hardness
Tensile Strength, Ultimate	620 - 795 MPa	90 - 115 ksi	
Tensile Strength, Yield	206 MPa	30000 psi	
Elongation at Break	30%	30%	
Modulus of Elasticity	164 GPa	24000 ksi	

Table 1

ELECTRICAL PROPERTIES	METRIC	ENGLISH	COMMENTS
Electrical Resistivity	7.2e-005 ohm-cm	7.2e-005 ohm-cm	

Table 2:

Thermal Properties	Metric	English	Comments
CTE, linear 20°C	17.2 µm/m-°C	9.56 µin/in-°F	from 0-100°C
CTE, linear 250°C	17.8 µm/m-°C	9.89 µin/in-°F	at 0-315°C (32-600°F)
CTE, linear 500°C	18.4 µm/m-°C	10.2 µin/in-°F	at 0-540°C, 18.7 µm/m-C at 0-650°C
Specific Heat Capacity	0.5 J/g-°C	0.12 BTU/lb-°F	from 0-100°C (32-212°F)
Thermal Conductivity	16.2 W/m-K	112 BTU-in /hr-ft²-°F	at 100°C (212°F), 21.5 W/m-K at 500°C (930°F)
Melting Point	1400 - 1420 °C	2550 - 2590 °F	
Solidus	1400 °C	2550 °F	

Table 3:

B. Material used in Structure Framing of Pneumatic Conveying System (Mild Steel)

Chemical Composition

Element	Content
Carbon, C	0.14 - 0.20 %
Iron, Fe	98.81 - 99.26 % (as remainder)
Manganese, Mn	0.60 - 0.90 %
Phosphorous, P	≤ 0.040 %
Sulfur, S	≤ 0.050 %

Table 4:

C. Physical Properties

Physical Properties	Metric	Imperial
Density	7.87 g/cc	0.284 lb/in^3

Table 5:

D. Mechanical Properties

Mechanical Properties	Metric	Imperial
Hardness, Brinell	126	126
Hardness, Knoop (Converted from Brinell hardness)	145	145
Hardness, Rockwell B (Converted from Brinell hardness)	71	71
Hardness, Vickers (Converted from Brinell hardness)	131	131
Tensile Strength, Ultimate	440 MPa	63800 psi
Tensile Strength, Yield	370 MPa	53700 psi
Elongation at Break (In 50 mm)	15.0 %	15.0 %
Reduction of Area	40.0 %	40.0 %
Modulus of Elasticity (Typical for steel)	205 GPa	29700 ksi
Bulk Modulus (Typical for steel)	140 GPa	20300 ksi
Poissons Ratio (Typical For Steel)	0.290	0.290

Machinability (Based on AISI 1212 steel. as 100% machinability)	70 %	70 %

Table 6:

E. Electrical Properties

Electrical Properties	Metric	English	Comments
Electrical resistivity @0°C (32°F)	0.0000159 Ω-cm	0.0000159 Ω-cm	annealed condition
@100 °C/ 212 °F	0.0000219 Ω-cm	0.0000219 Ω-cm	annealed condition
@ 200 °C/392 °F	0.0000293 Ω-cm	0.0000293 Ω-cm	annealed condition

Table 7:

F. Machining

1) Related Stories

- AISI 1018 Carbon Steel (UNS G10180)
- High Strength Steel
- Comprehensive Market Research Report on US Steel Industry

The machinability of AISI 1018 mild/low carbon steel is graded at 78% of B1112.

G. Weldability

AISI 1018 mild/low carbon steel can be instantly welded by all the conventional welding processes. Welding is not recommended for AISI 1018 mild/low carbon steel when it is carbonitrided and carburized.

Low carbon welding electrodes are to be used in the welding procedure, and post-heating and pre-heating are not necessary. Pre-heating can be performed for sections over 50 mm. Post-weld stress relieving also has its own beneficial aspects like the pre-heating process.

H. Heat Treatment

The heat treatment for AISI 1018 mild/low carbon steel consists of the following processes:

I. Normalizing

AISI 1018 mild/low carbon steel should be heated at 890°C – 940°C and then cooled in still air.

J. Forging

- This process requires heating between 1150°C – 1280°C and AISI 1018 mild/low carbon steel is held until the temperature becomes constant.
- 900°C is the minimum temperature required for the forging process.
- The steel is then cooled in air after this process.

K. Tempering

- AISI 1018 mild/low carbon steel is tempered at between 150°C – 200°C for improvement of case toughness. This process has little or no effect on hardness.
- The occurrence of grinding cracks is reduced when AISI 1018 mild/low carbon steel is tempered at the above mentioned temperature.

L. Annealing

- The AISI 1018 mild/low carbon steel is heated at 870°C – 910°C and allowed to cool in a furnace

M. Stress Relieving

- 500°C – 700°C is required to relieve stress in AISI 1018 mild/low carbon steel that is later cooled down in still air.

N. Case Hardening

- This process requires heating to be carried out between 780°C – 820°C. AISI 1018 mild/low carbon steel is then quenched in water.

O. Core Refining

- This is an optional process that requires heating at 880°C – 920°C.
- AISI 1018 mild/low carbon steel after being heated is moistened in oil or water.

P. Carburizing

- Carburizing takes place at 880°C – 920°C.

Q. Applications of AISI 1018 Mild/Low Carbon Steel

- It is used in bending, crimping and swaging processes.
- Carburized parts that include worms, gears, pins, dowels, non-critical components of tool and die sets, tool holders, pinions, machine parts, ratchets, dowels and chain pins use AISI 1018 mild/low carbon steel.
- It is widely used for fixtures, mounting plates and spacers.
- It is suitably used in applications that do not need high strength of alloy steels and high carbon.
- It provides high surface hardness and a soft core to parts that include worms, dogs, pins, liners, machinery parts, special bolts, ratchets, chain pins, oil tool slips, tie rods, anchor pins, studs etc.
- It is used to improve drilling, machining, threading and punching processes.

VIII. ADVANTAGES

Pneumatic control systems are widely used in our society, especially in the industrial sectors for the driving of automatic machines. Pneumatic systems have a lot of advantages.

A. High Effectiveness

Many factories have equipped their production lines with compressed air supplies and movable compressors. There is an unlimited supply of air in our atmosphere to produce compressed air. Moreover, the use of compressed air is not restricted by distance, as it can easily be transported through pipes. After use, compressed air can be released directly into the atmosphere without the need of processing.

B. High Durability & Reliability

Pneumatic components are extremely durable and cannot be damaged easily. Compared to electromotive components, pneumatic components are more durable and reliable.

C. Simple Design

The designs of pneumatic components are relatively simple. They are thus more suitable for use in simple automatic control systems.

D. High Adaptability to Harsh Environment

Compared to the elements of other systems, compressed air is less affected by high temperature, dust, corrosion, etc.

E. Safety

Pneumatic systems are safer than electromotive systems because they can work in inflammable environment without causing fire or explosion. Apart from that, overloading in pneumatic system will only lead to sliding or cessation of operation. Unlike electromotive components, pneumatic components do not burn or get overheated when overloaded.

F. Easy Selection of Speed & Pressure

The speeds of rectilinear and oscillating movement of pneumatic systems are easy to adjust and subject to few limitations. The pressure and the volume of air can easily be adjusted by a pressure regulator.

G. Environmental Friendly

The operation of pneumatic systems do not produce pollutants. The air released is also processed in special ways. Therefore, pneumatic systems can work in environments that demand high level of cleanliness. One example is the production lines of integrated circuits.

H. Economical

As pneumatic components are not expensive, the costs of pneumatic systems are quite low. Moreover, as pneumatic systems are very durable, the cost of repair is significantly lower than that of other systems.

IX. DISADVANTAGES

Although pneumatic systems possess a lot of advantages, they are also subject to many limitations.

A. Relatively Low Accuracy

As pneumatic systems are powered by the force provided by compressed air, their operation is subject to the volume of the compressed air. As the volume of air may change when compressed or heated, the supply of air to the system may not be accurate, causing a decrease in the overall accuracy of the system.

B. Low Loading

As the cylinders of pneumatic components are not very large, a pneumatic system cannot drive loads that are too heavy

C. Processing Required Before Use

Compressed air must be processed before use to ensure the absence of water vapour or dust.

Otherwise, the moving parts of the pneumatic components may wear out quickly due to friction.

D. Uneven Moving Speed

As air can easily be compressed, the moving speeds of the pistons are relatively uneven.

E. Noise

Noise will be produced when compressed air is released from the pneumatic components.

X. PNEUMATIC APPLICATION

There is a wide rane of scope and application for pneumatic system

Some of the few examples are

1) Pneumatically powered surgical cutting and fastening instrument
2) Pneumatically shifted reciprocating pump
3) Microprocessor based electro-pneumatic locomotive brake control
4) Electro-pneumatic freight brake control system ETC...

XI. APPLICATION OF PNEUMATIC CONVEYING SYSTEM

- This system is widely use for the material handling process
- It receives the raw material from the initial point and transfer it to the machining point with more accuracy and precision
- Some of the examples are

1) Automobile industries where several parts have to be transfer from one place to other
2) It can also be used in aerospace industries for transferring heavy parts with more accuracy
3) For caring the heavy packaging cartoons in the industries
4) Can also be used as automatic storage and retrieval system

- This system transfers the raw material with high speed which results in increasing the production rate
- moving large, small, heavy, or hand to handle products can be easily transferred in the industry

XII. FUTURE SCOPE

- We can improve the design and can increase the range of working area
- We can do automation in this system
- In future using the telescopic actuators we can reduce the space occupied by the system
- We can provide the machine with better gripping system
- Automatic controlled actuators (bang bang controller) can be use in

XIII. SUMMARY

With the help of force control and positioning through pneumatic we can easily transfer load from one point to another as per the desired location. As this system work on the automation it is easy to operate which reduces the load on the worker results in the increasing the efficiency of the worker and reduces the time delay which results in increasing the productivity of the company. Also the maintenance cost of this system is very low and also it is easy to operate.

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